NACA

RESEARCH MEMORANDUM

PRELIMINARY PERFORMANCE DATA OBTAINED IN A FULL-SCALE, FREE-JET INVESTIGATION OF A SIDE-INLET SUPERSONIC DIFFUSER

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Cleveland, Ohio

NATIONAL ADVISORY COMMITTEE
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SUMMARY

An investigation of a full-scale, four-shock, side-inlet diffuser was conducted at the NACA Lewis laboratory in a free-jet facility at a Mach number of 3.16. This diffuser was designed by the missile manufacturer for test purposes and was a heavy-duty version of the diffuser to be used with the XRJ47-W-7 engine. Throughout the investigation, the diffuser was operated supercritically at a zero angle of attack.

The supercritical capture-area ratio of the diffuser was about 1.04, and the critical total-pressure recovery was about 0.58 during cold-flow operation. With the combustor in operation, the maximum observed pressure recovery was about 0.564. The diffuser-exit flow was reasonably uniform near critical total-pressure recovery and became increasingly nonuniform as the operating point moved farther into the supercritical region.

INTRODUCTION

An investigation of the full-scale XRJ47-W-7 engine is being conducted at the NACA Lewis laboratory in a free-jet facility at a Mach number of 3.16. As a part of the over-all program, an investigation was made to evaluate some of the internal performance characteristics of the supersonic inlet diffuser. The diffuser was designed by the missile manufacturer for free-jet tests and was a heavy-duty version of the diffuser to be used with the XRJ47-W-7 engine. The diffuser is a side-inlet type; the supersonic portion is essentially a 216° segment of a four-shock, Ferri-type diffuser. Internally, the diffuser is designed to provide some turning of the air in addition to diffusion to the exit area.

Diffuser performance is presented in terms of capture-area ratio, total-pressure recovery, pressure distribution, internal-shock position, and uniformity of exit flow. Data are presented for a range of diffuser pressure recoveries and free-stream total pressures. All data were obtained with the inlet diffuser at a zero angle of attack in a free-jet facility at a Mach number of 3.16. Early-model tests by the missile manufacturer indicated that this flow angle and Mach number would be representative of the flow conditions approaching the inlet at the design cruise Mach number and angle of attack of the missile.

APPARATUS

Diffuser

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Photographs of the heavy-duty diffuser (designated I_5D_5 by the missile manufacturer) are shown in figure 1. Figure 2 shows dimensions of the four-shock spike inlet. Variation of diffuser flow area (normal to the average flow) as a function of missile station is shown in figure 3.

Installation

Installation of the diffuser and the combustor in the free-jet facility is shown in figure 4. The supersonic diffuser inlet was mounted within the Mach cone of a 3.16 Mach-number supersonic nozzle. Air not captured by the supersonic inlet was diffused to the exhaust-section pressure by means of the jet external, second-throat diffuser and also the bottom-plate boundary-layer bleed duct (fig. 4). The outlet of the diffuser was connected to the 48-inch-diameter engine combustor. A clamshell-type throttle was installed on the convergent-divergent exhaust nozzle to permit variations in diffuser pressure recovery during cold-flow operation.

Instrumentation

Free-stream total pressure and temperature were obtained from a survey of 24 total-pressure tubes and 20 iron-constantan thermocouples, respectively, at the inlet of the supersonic free-jet nozzle (instrumentation station 0, fig. 4).

Diffuser instrumentation is summarized in figure 5. Diffuser-outlet total pressure was obtained from survey rakes at station 3 (missile station 855). The internal-wall static pressures of the diffuser were obtained along longitudinal instrumentation rows both on the inner body and cowl; these static pressures indicated internal pressure distribution and shock position and were potential engine-control signal pressures. Two trailing-stream static-pressure probes and three trailing total-pressure probes were also installed as potential engine-control signal pressures; details of these probes are shown in figure 5. The instrumentation rows are shown in figure 5, and the longitudinal locations of the various types of instrumentation are summarized in table I.

PROCEDURE

Data were obtained over a range of diffuser pressure recoveries from about 0.37 to critical at a free-jet Mach number of 3.16 and a diffuser angle of attack of zero. To obtain the desired diffuser-inlet conditions, the inlet total temperature was first set with the facility combustion-air heaters. The supersonic nozzle-inlet total pressure was then adjusted to give the desired airflow. Diffuser pressure recovery was varied by using a clamshell-type throttle on the exhaust nozzle when the combustor was not operating. With the combustor operating, recovery was varied by changing the engine fuel-air ratio.

The nominal inlet conditions at which data were obtained are shown in the following table:

Engine airflow, W_a, lb/sec	Inlet total pressure, P_0, lb/sq ft	Inlet total temperature, T_0, °F
56	2400	760
84	3600	760
112	4800	760

Symbols are defined in appendix A and methods of calculation are shown in appendix B.

PRESENTATION OF DATA

Characteristic curves showing the relation between individual internal-diffuser pressures and diffuser total-pressure recovery are presented in figures 6, 7, and 8; this relation is significant in the selection of potential engine-control pressures. In all cases, the internal-diffuser pressures are presented as ratios to free-stream total pressure. The characteristic curves for wall static pressures from the various instrumentation rows are presented in figure 6, and the available characteristic curves for trailing-stream static pressures and trailing total pressures are presented in figure 7; these data were obtained at a free-stream total pressure of 4800 pounds per square foot absolute. The effect of free-stream total pressure (or altitude) on the characteristic curves of wall static pressure from instrumentation row B (selected as representative) is shown in figure 8.

The effect of diffuser total-pressure recovery on the longitudinal wall static-pressure distributions along two of the instrumentation rows is shown in figure 9 for operation at a free-stream total pressure of 4800 pounds per square foot absolute. The curve through the solid symbols indicates the full supercritical diffuser pressures. As the internal shock system is moved forward in the diffuser, the pressures rise above the supercritical values.

The data of figures 6 to 9 and similar data can be used to define approximately the relation between diffuser total-pressure recovery and internal-shock position. The effect of free-stream total pressure on this relation is shown in figure 10; the wall static pressures along row B were used to define the approximate internal-shock position. 4388

Information relative to the uniformity of flow at the diffuser exit is presented in figures 11 and 12. Diffuser-exit Mach-number contours are presented in figure 11 for several diffuser total-pressure recoveries at a free-stream total pressure of 4800 pounds per square foot absolute with cold-flow (fig. 11(a)) and hot-flow (fig. 11(b)) operation. A comparison of the average Mach number M_{av} and the continuity Mach number M_{con} at station 3 over the range of diffuser total-pressure recoveries, together with the variation of the flow-profile factor $(\Delta M/M_{av})$ with total-pressure recovery, is given in figure 12.

RESULTS

The supercritical capture-area ratio of the I_5D_5 (heavy-duty) diffuser was 1.04 (see appendix B) for the range of free-stream total pressures investigated. A capture-area ratio greater than 1.00 is due to the design of the inlet, because the tip of the spike was not on the centerline of the cowl (fig. 2).

The critical diffuser total-pressure recovery was about 0.58 over the range of free-stream total pressures during cold-flow operation. With the engine combustor in operation, however, the maximum observed diffuser total-pressure recovery was about 0.564 over the range of free-stream total pressures. The difference in maximum diffuser total-pressure recovery between cold-flow and hot-flow operation may be due to pressure pulsations with combustion. It is presumed that the maximum pressure recovery of the diffuser would be obtained without airflow spillage, that pressure pulsations during cold-flow operation were small as compared with those during operation with combustion, and that pressure pulsations would cause airflow spillage at a lower average-pressure recovery, and thus reduction of the maximum diffuser pressure recovery would result.

In general, the diffuser-exit flow profiles became poorer as the total-pressure recovery was lowered from the maximum value (or as the internal-shock system was allowed to move downstream). Combustor problems attributable to adverse diffuser-exit profiles were not encountered, and combustion had no significant effect on the profiles. Separation of the diffuser-exit flow was observed only for extreme supercritical operation. Diffuser performance, in terms of supercritical capture-area ratio, maximum pressure recovery, and internal pressure distribution, was essentially unaffected by variations in free-stream total pressure (altitude) within the range investigated.

Lewis Flight Propulsion Laboratory
National Advisory Committee for Aeronautics
Cleveland, Ohio, June 4, 1957

APPENDIX A

SYMBOLS

A	cross-sectional area, sq ft
g	acceleration due to gravity, ft/sec^2
M	Mach number 4398
M_{av}	average Mach number
M_{con}	continuity Mach number
M_i	Mach number at individual total-pressure tube
$\Delta M/M_{av}$	profile factor, $\dfrac{\frac{1}{n}\sum_{1}^{n}(M_i - M_{av})}{M_{av}}$
n	number of local Mach numbers in rake obtained at each total-pressure tube
P	total pressure, lb/sq ft abs
p	static pressure, lb/sq ft abs
R	gas constant, 53.3 ft lb/lb $^{\circ}$R
T	total temperature, $^{\circ}$R
W_a	airflow, lb/sec
γ	ratio of specific heats

Subscripts:

c	cowl
0	inlet to supersonic nozzle (free stream)
3	diffuser-outlet instrumentation station

APPENDIX B

CALCULATIONS

Diffuser capture-area ratio A_0/A_c. - The equation for airflow can be expressed as

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$$W_a = \sqrt{\frac{\gamma g}{R}} \frac{M_0}{\left(1 + \frac{\gamma - 1}{2} M_0^2\right)^{\frac{\gamma+1}{2(\gamma-1)}}} A_c \frac{A_0}{A_c} \frac{P_0}{\sqrt{T_0}} \tag{B1}$$

When $\gamma = 1.4$, $M_0 = 3.16$, and $A_c = 7.2777$ square feet,

$$W_a = 0.10786\ A_c \frac{A_0}{A_c} \frac{P_0}{\sqrt{T_0}} = 0.785 \frac{A_0}{A_c} \frac{P_0}{\sqrt{T_0}}$$

From an airflow calibration of the diffuser, the supercritical airflow was given by the following:

$$W = 0.816 \frac{P_0}{\sqrt{T_0}}$$

from which

$$0.785 \frac{A_0}{A_c} \frac{P_0}{\sqrt{T_0}} = 0.816 \frac{P_0}{\sqrt{T_0}}$$

and therefore,

$$\frac{A_0}{A_c} = \frac{0.816}{0.785} = 1.04$$

Diffuser total-pressure recovery. - Diffuser total-pressure recovery was taken as the ratio of the average total pressure measured at station 3 (diffuser-outlet instrumentation station) to the average total pressure measured at the supersonic nozzle inlet (station 0). Consequently, any total-pressure losses occurring in the supersonic nozzle were charged to the diffuser. The pressure tubes at station 3 were placed on centers of equal area; therefore, area-weighted rather than mass-weighted values of the diffuser-outlet pressure were obtained.

Diffuser-outlet Mach-number profiles. - Mach numbers were calculated from the ratio of static to total pressure at each of the total-pressure tubes with a γ value of 1.365. Although stream static-pressure tubes were installed, values obtained with these tubes were not considered reliable. Therefore, in determining the Mach number at each total-pressure tube, the corresponding static pressure used was the average of the two wall static-pressure measurements on either side of the respective total-pressure rake segments at station 3. The area-weighted average of all of the Mach numbers from the total-pressure tubes of the six rakes was considered as the average Mach number M_{av} at station 3. 4398

The continuity Mach number M_{con} was calculated as follows from the average total-pressure ratio P_3/P_0, airflow, and area at station 3:

$$W_a = \frac{\sqrt{\frac{\gamma g}{R}}\, P_3 A_3}{\sqrt{T_3}} \left[\frac{M_{con}}{\left(1 + \frac{\gamma - 1}{2} M_{con}^2\right)^{\frac{\gamma+1}{2(\gamma-1)}}} \right] \tag{B2}$$

From an airflow calibration of the engine, the engine airflow was

$$W_a = \frac{0.816\, P_0}{\sqrt{T_0}} \tag{B3}$$

Assuming that $T_3 = T_0$

$$\frac{0.816\, P_0}{\sqrt{T_0}} = \frac{\sqrt{\frac{\gamma g}{R}}\, P_3 A_3}{\sqrt{T_0}} \left[\frac{M_{con}}{\left(1 + \frac{\gamma - 1}{2} M_{con}^2\right)^{\frac{\gamma+1}{2(\gamma-1)}}} \right] \tag{B4}$$

A transposition of equation (B4) yields

$$\frac{P_3}{P_0} = \frac{0.816}{\sqrt{\frac{\gamma g}{R}}\, A_3} \left[\frac{\left(1 + \frac{\gamma - 1}{2} M_{con}^2\right)^{\frac{\gamma+1}{2(\gamma-1)}}}{M_{con}} \right] \tag{B5}$$

from which the continuity Mach number M_{con} can be obtained where

$$\gamma_3 = 1.365$$

$$A_3 = 7.022 \text{ sq ft}$$

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TABLE I. - LOCATION AND TYPE OF INSTRUMENTATION

Missile station	Row	Tap type (a)	Missile station	Row	Tap type (a)	Missile station	Row	Tap type (a)	Missile station	Row	Tap type (a)
542	A	S	550	G	S	562.5	B	S	590	B	S
542	B	S	552.5	B	S	565	B	ST	590	F	S
542	D	S	555	A	S	565	B	S	600	B	S
543	F	S	555	B	S	565	B	TT	600	F	S
545	A	S	555	D	S	565	F	S	620	B	S
545	B	S	555	E	S	567.5	B	S	620	F	S
545	D	S	555	F	S	570	B	ST	640	B	S
545	E	S	555	G	S	570	B	S	640	F	S
545	F	S	557.5	B	S	570	B	TT	660	B	S
545	G	S	560	A	S	570	F	S	660	F	S
547	F	S	560	B	S	572.5	B	S	702	B	S
550	A	S	560	B	TT	575	B	S	702	F	S
550	B	S	560	D	S	575	F	S	740	F	S
550	D	S	560	E	S	577.5	B	S	780	F	S
550	E	S	560	F	S	580	B	S	820	F	S
550	F	S	560	G	S	580	F	S	855	B	S
									855	-	T

[a]S Static-pressure tap
T Total-pressure probe
TT Trailing total-pressure probe
ST Trailing-stream static-pressure probe

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(a) Diffuser inlet.

Figure 1. - Heavy-duty diffuser (I_5D_5).

(b) View looking upstream through diffuser duct.

Figure 1. - Concluded. Heavy-duty diffuser (I_5D_5).

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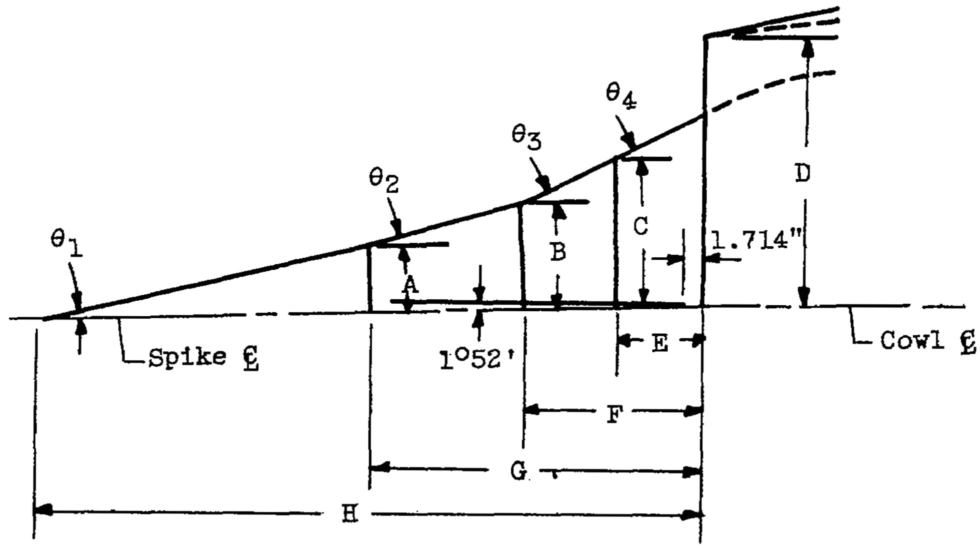


	Dimensions, in.
A	5.964
B	9.685
C	13.093
D	23.600
E	7.104
F	15.014
G	27.772
H	55.823

Spike angle (relative to spike), deg	
θ_1	12.00
θ_2	16.27
θ_3	23.33
θ_4	31.22

Cowl angle (relative to cowl), deg	
External	13.5
Internal	9.0

Figure 2. - Dimensions of heavy-duty diffuser (I_5D_5) spike.

[redacted]

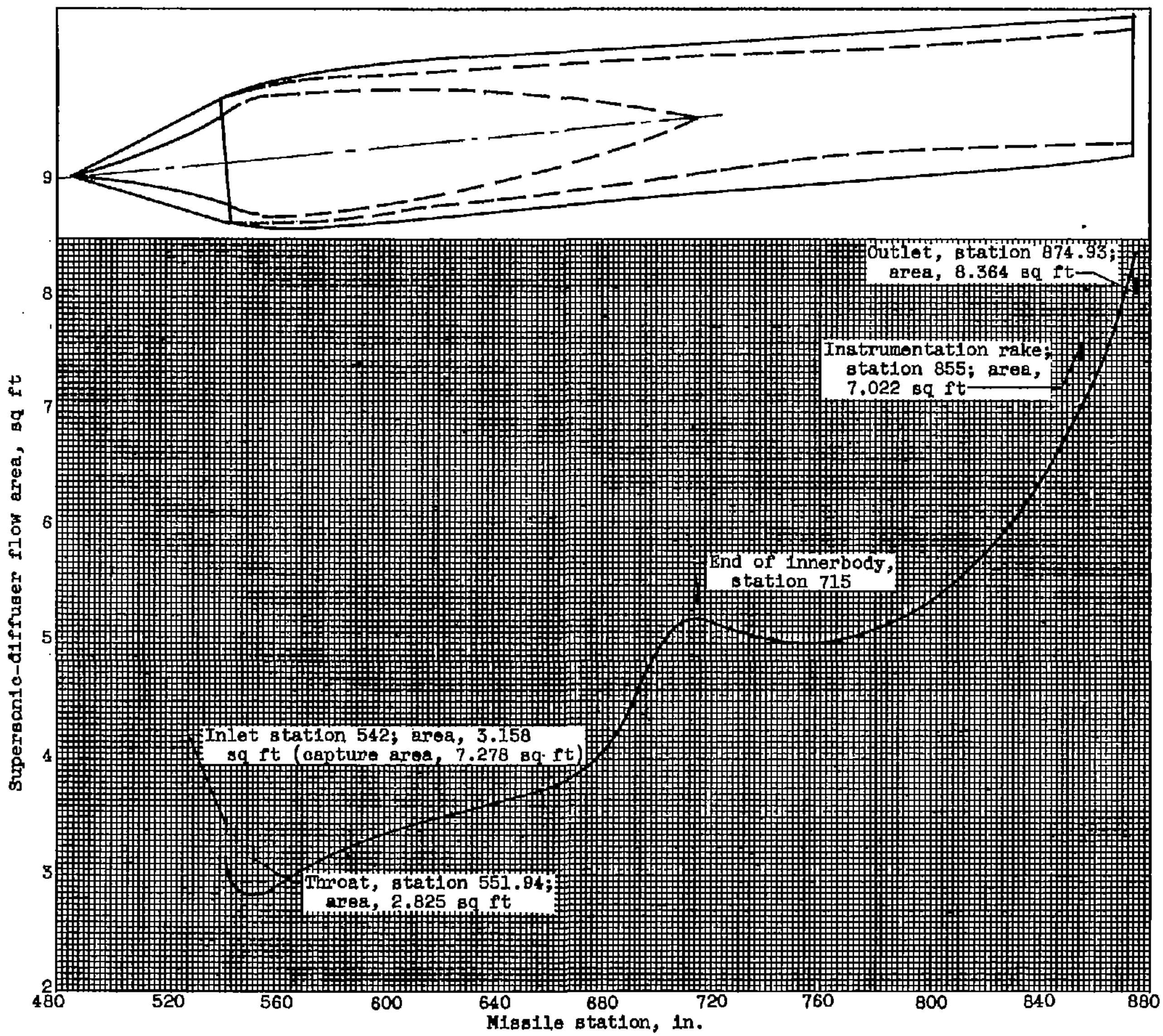


Figure 3. - Diffuser area variation.

[redacted]

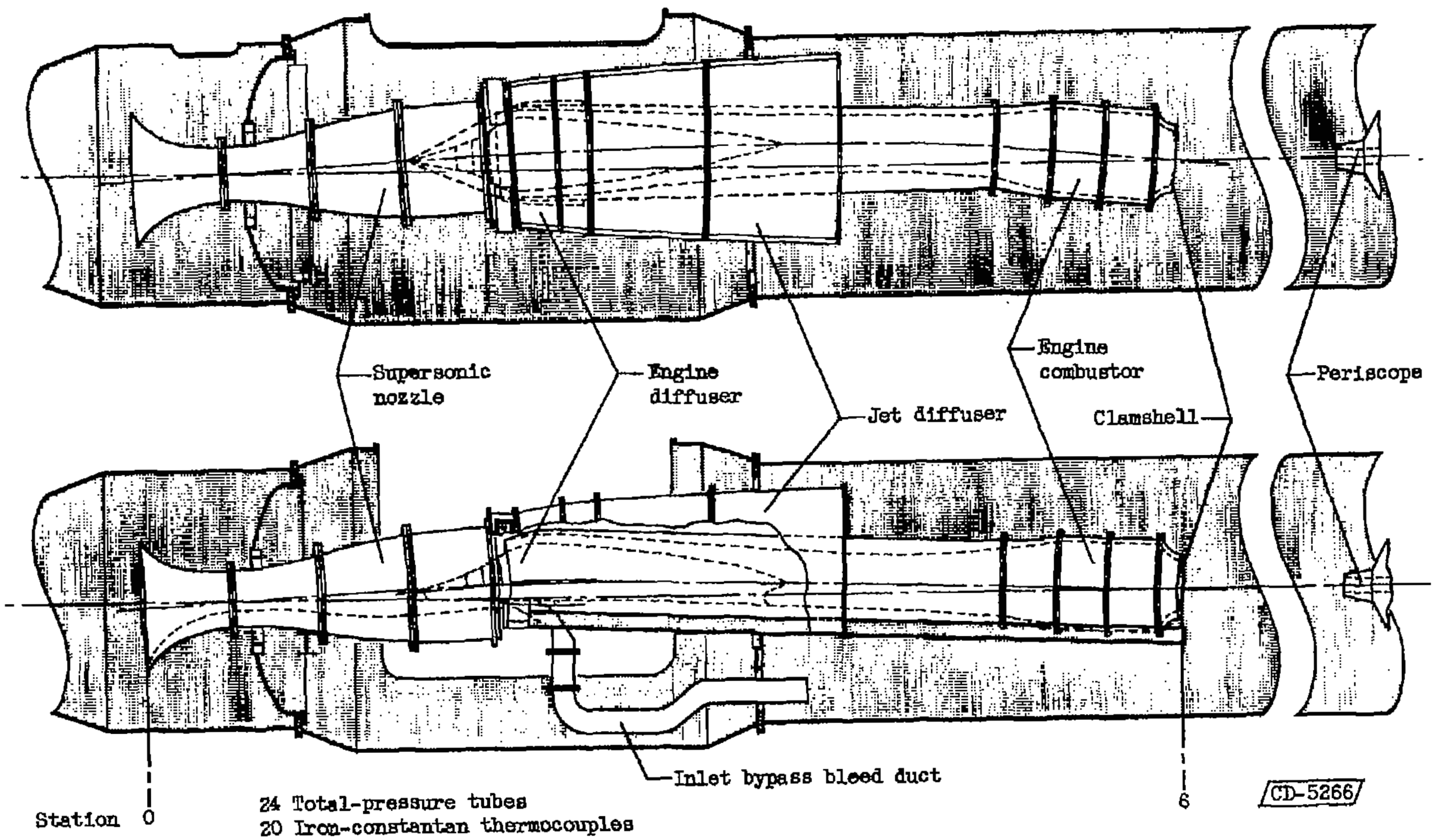
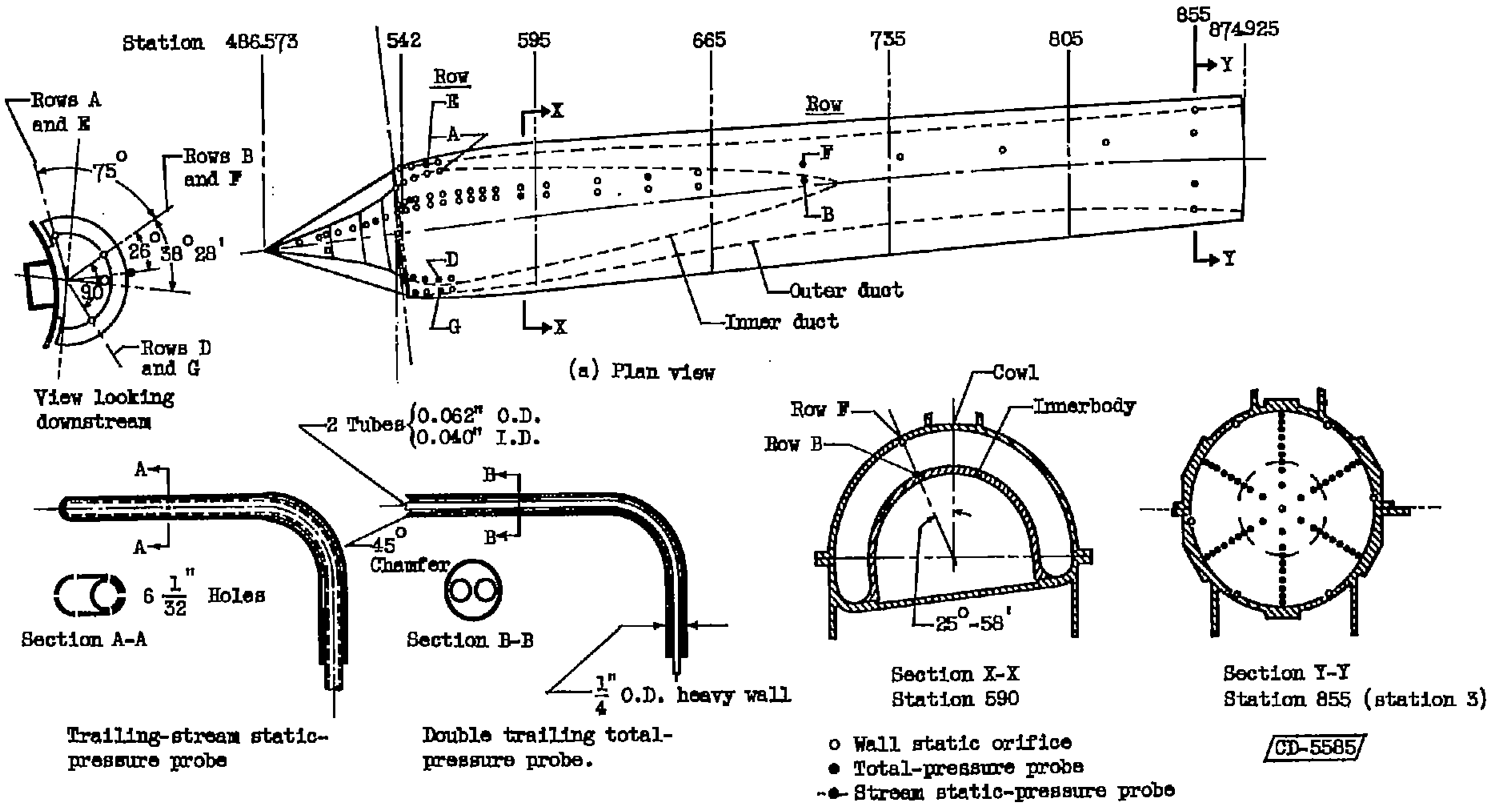


Figure 4. - Free-jet test facility and engine installation.



(b) Diffuser instrumentation stations

Figure 5. - Instrumentation detail.

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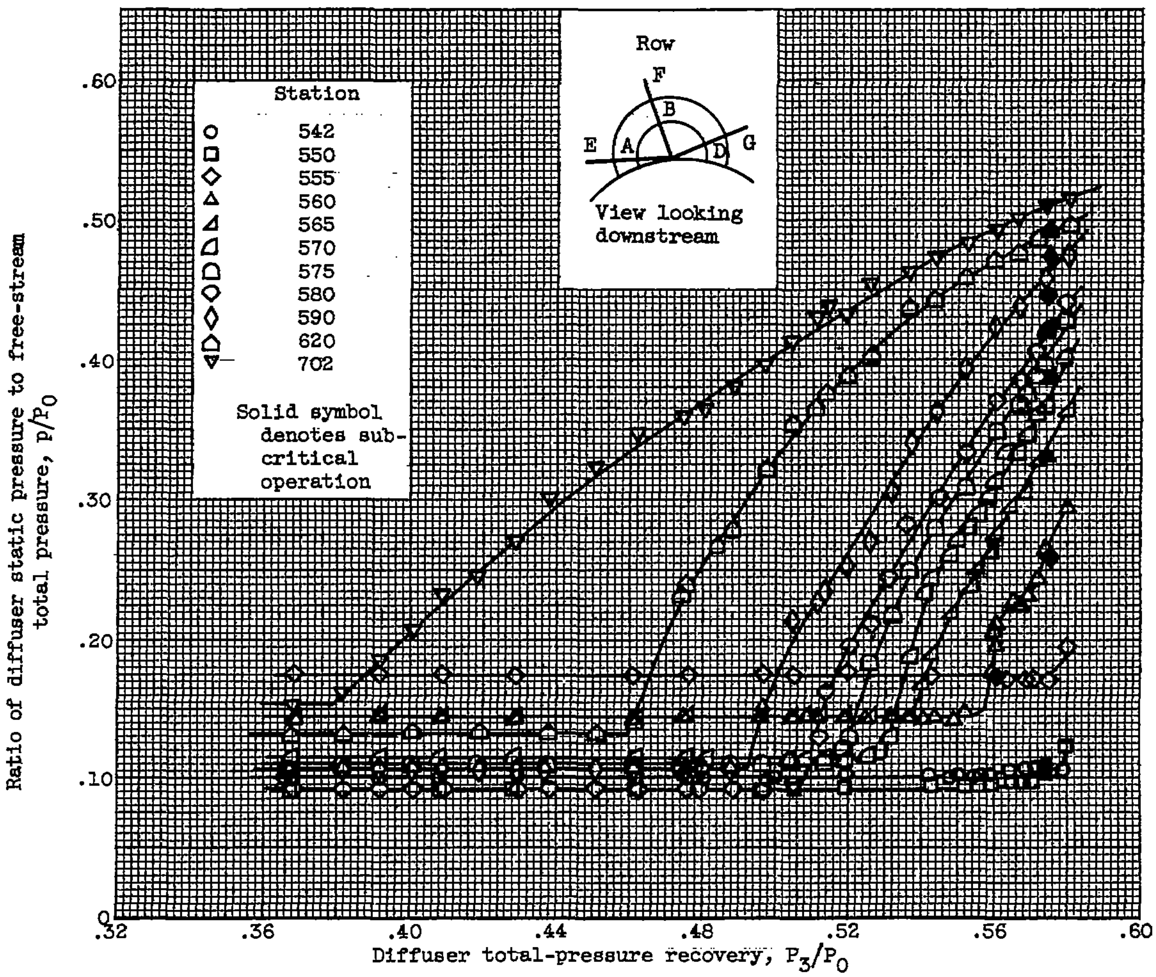

(a) Instrumentation row B (inner body).

Figure 6. - Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.

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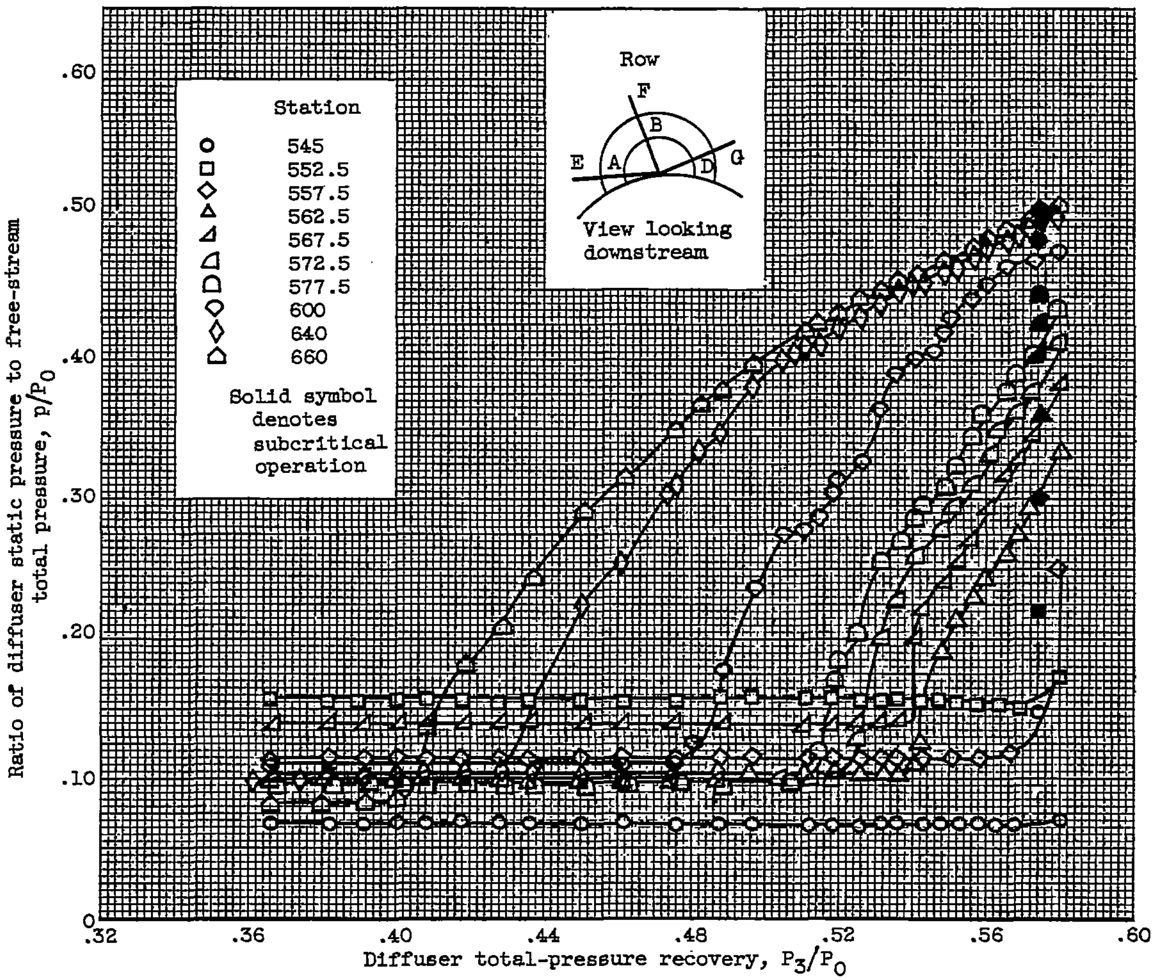

(a) Concluded. Instrumentation row B (inner body).

Figure 6. - Continued. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.

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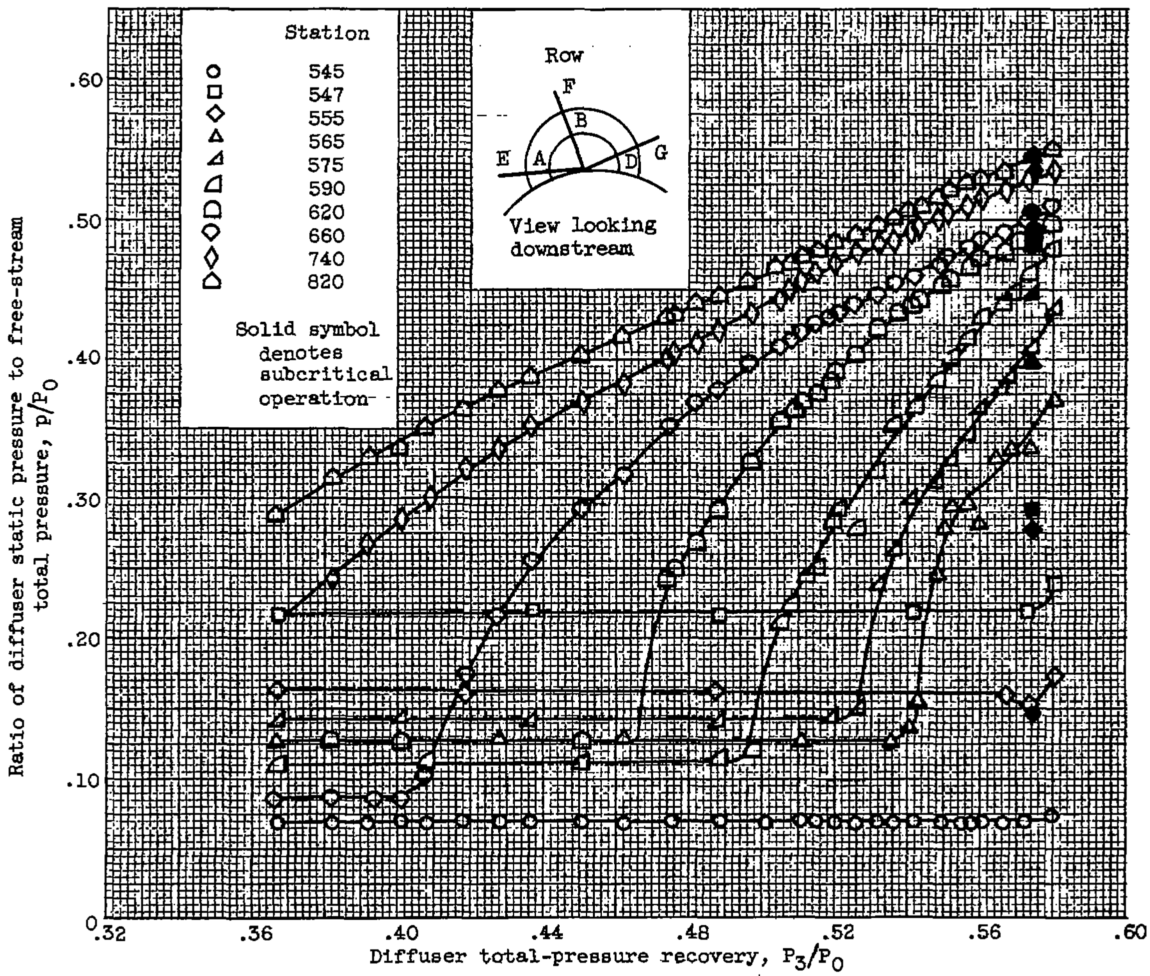

(b) Instrumentation row F (cowl).

Figure 6. - Continued. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.

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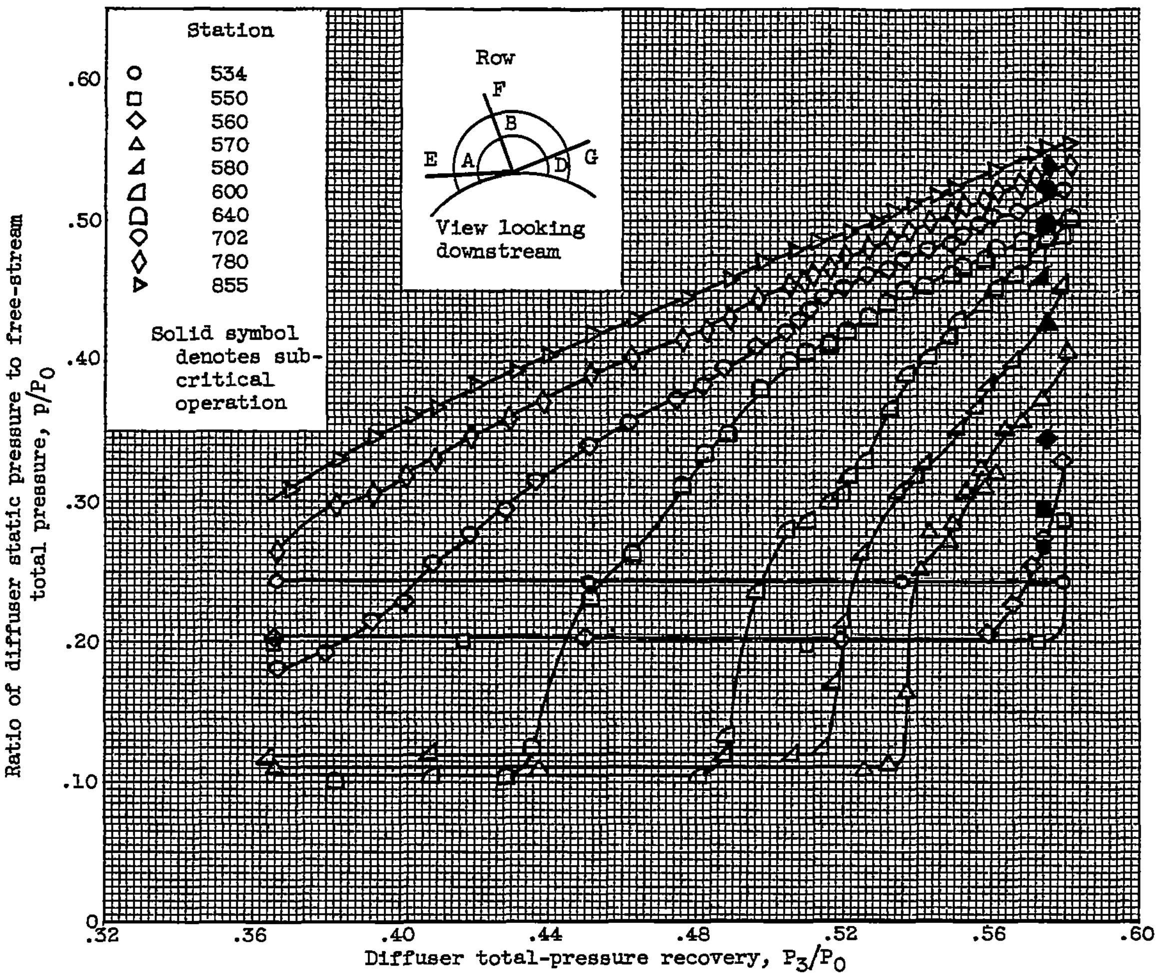
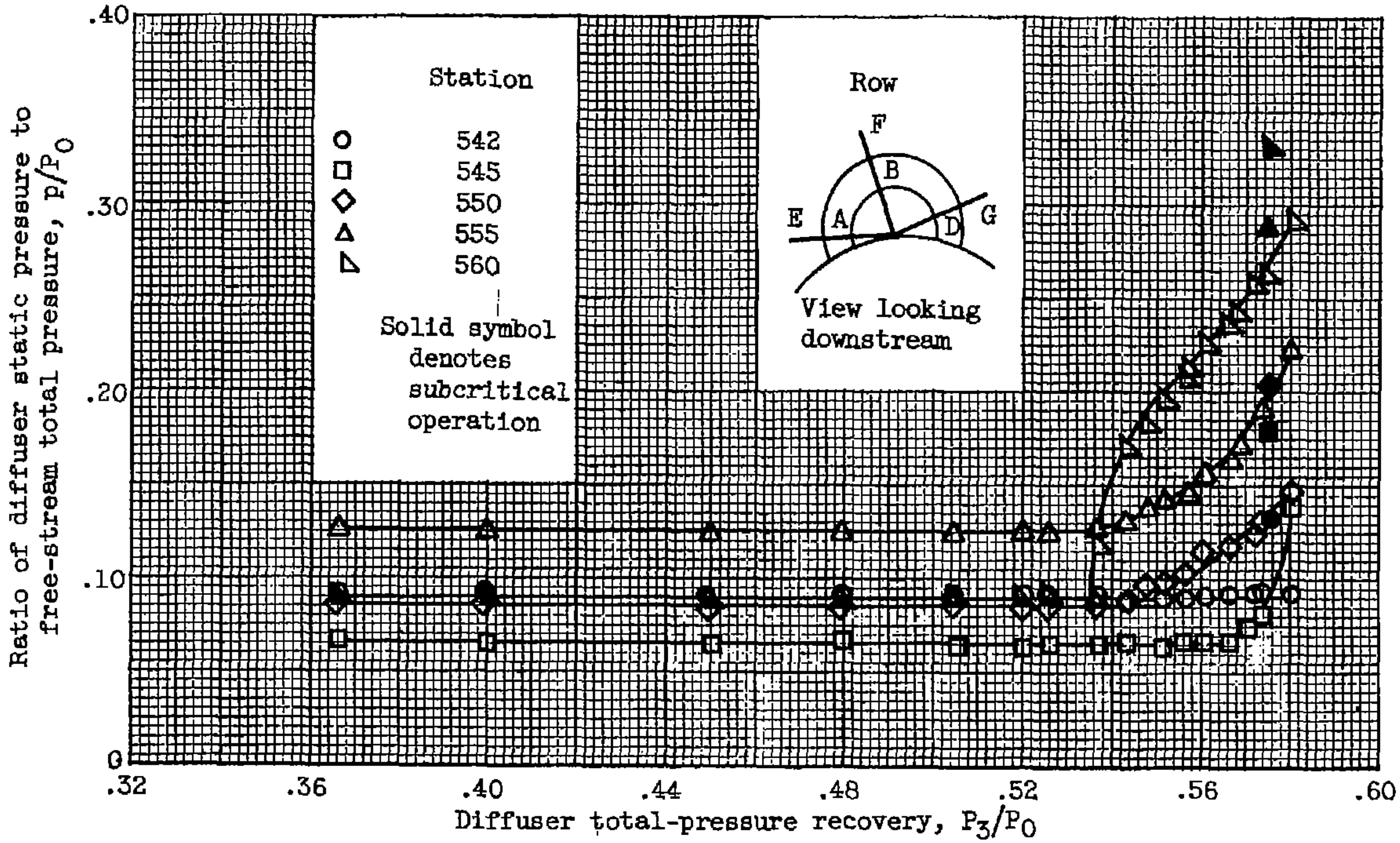


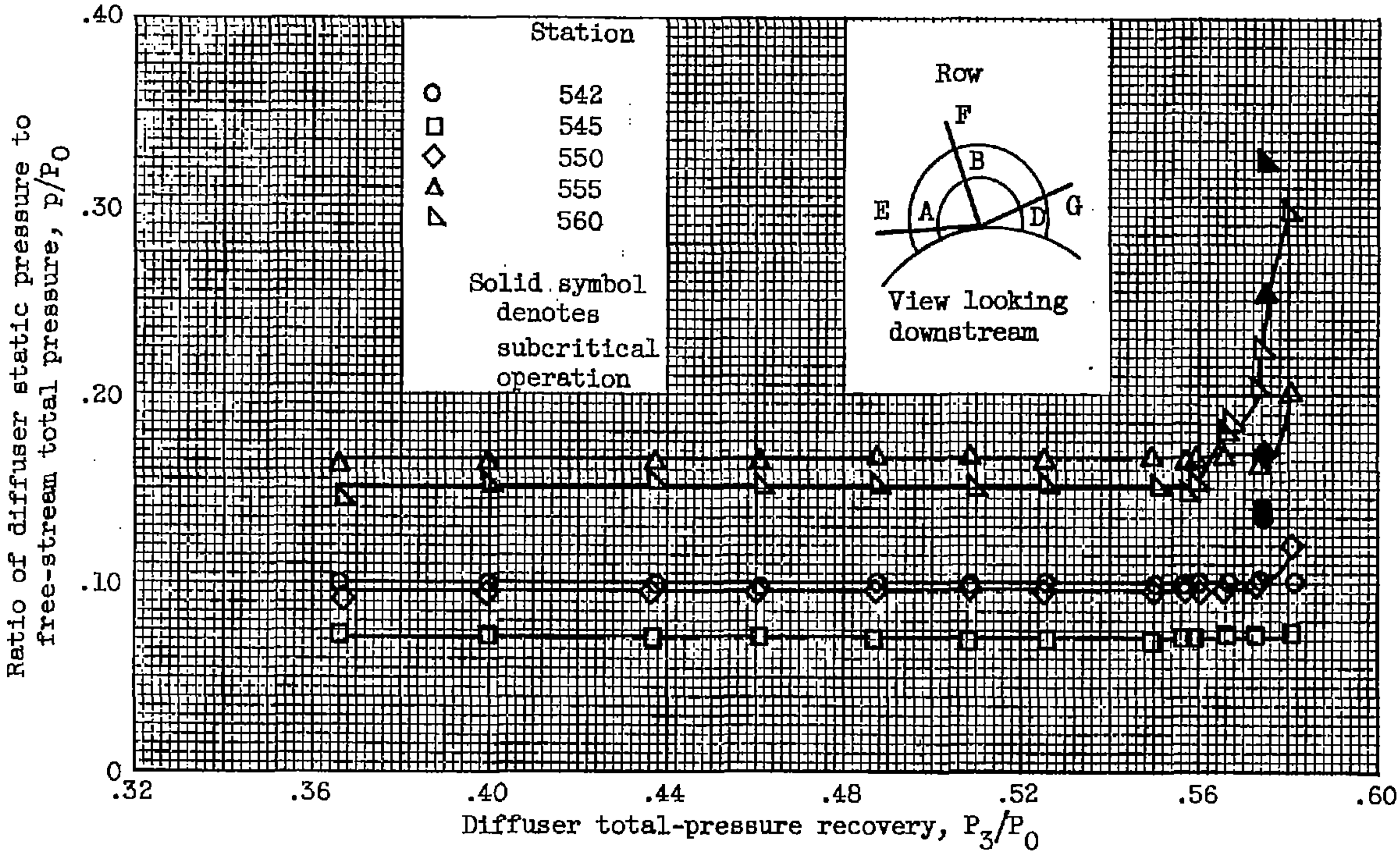
(b) Concluded. Instrumentation row F (cowl).

Figure 6. - Continued. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



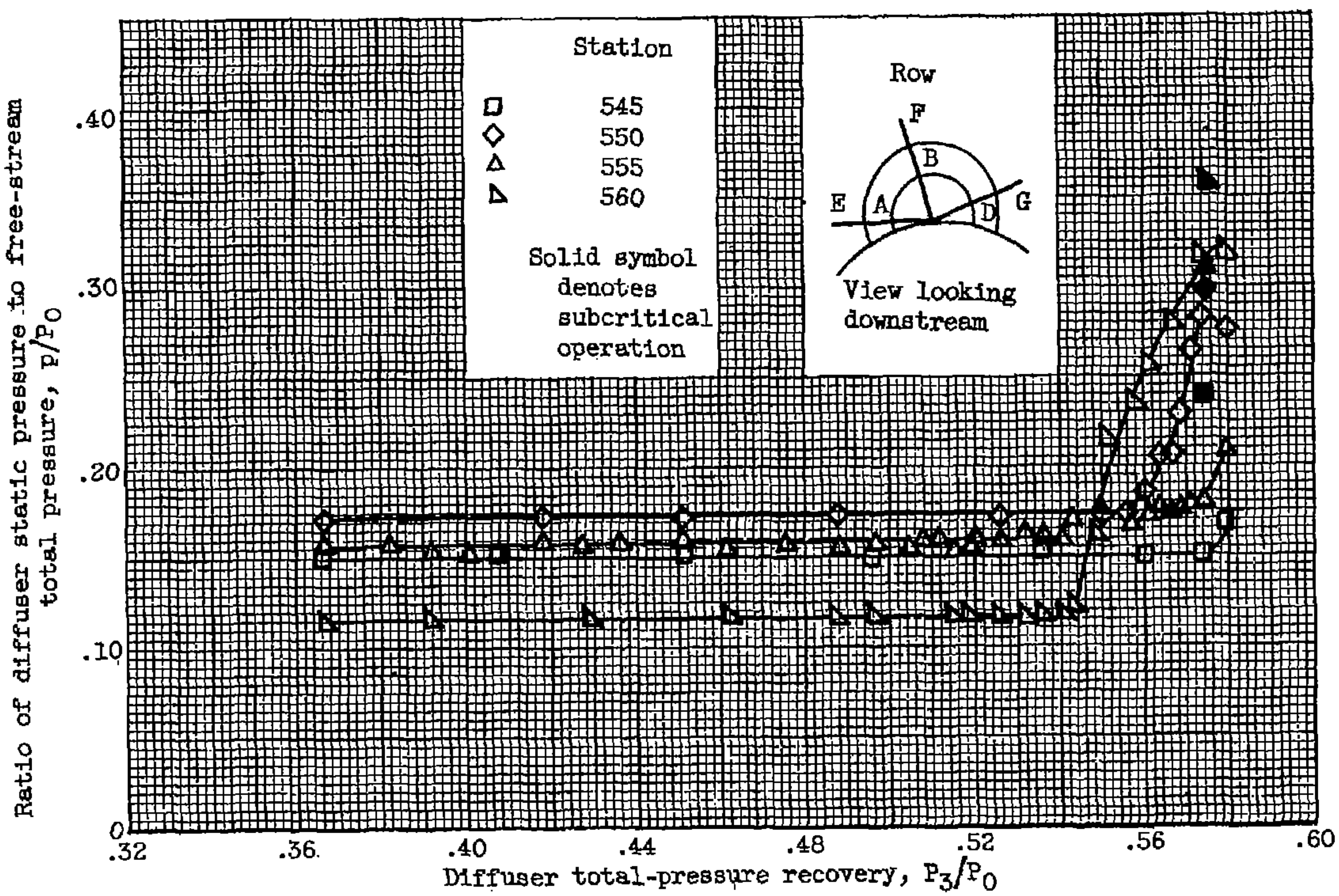
(c) Instrumentation row A (inner body).

Figure 6. - Continued. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



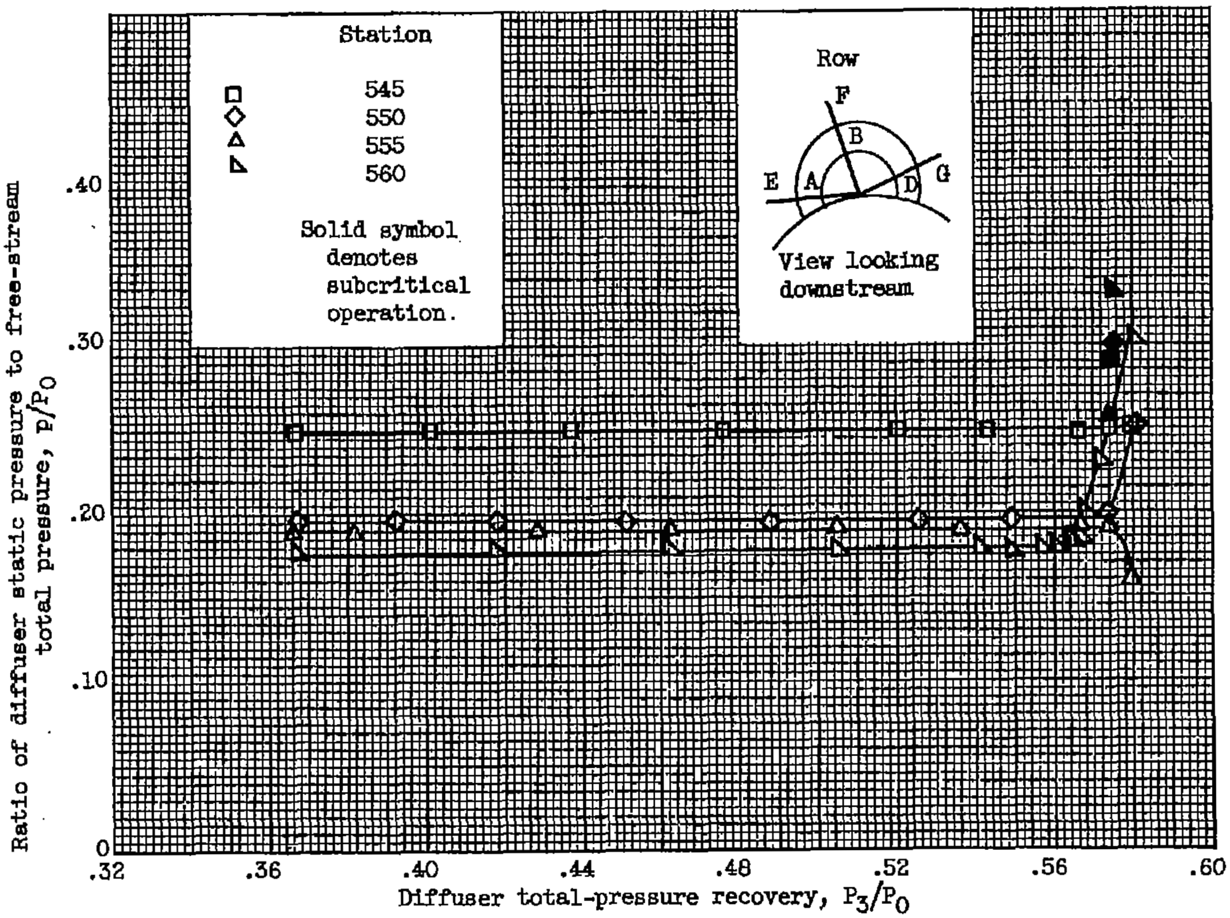
(d) Instrumentation row D (inner body).

Figure 6. - Continued. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



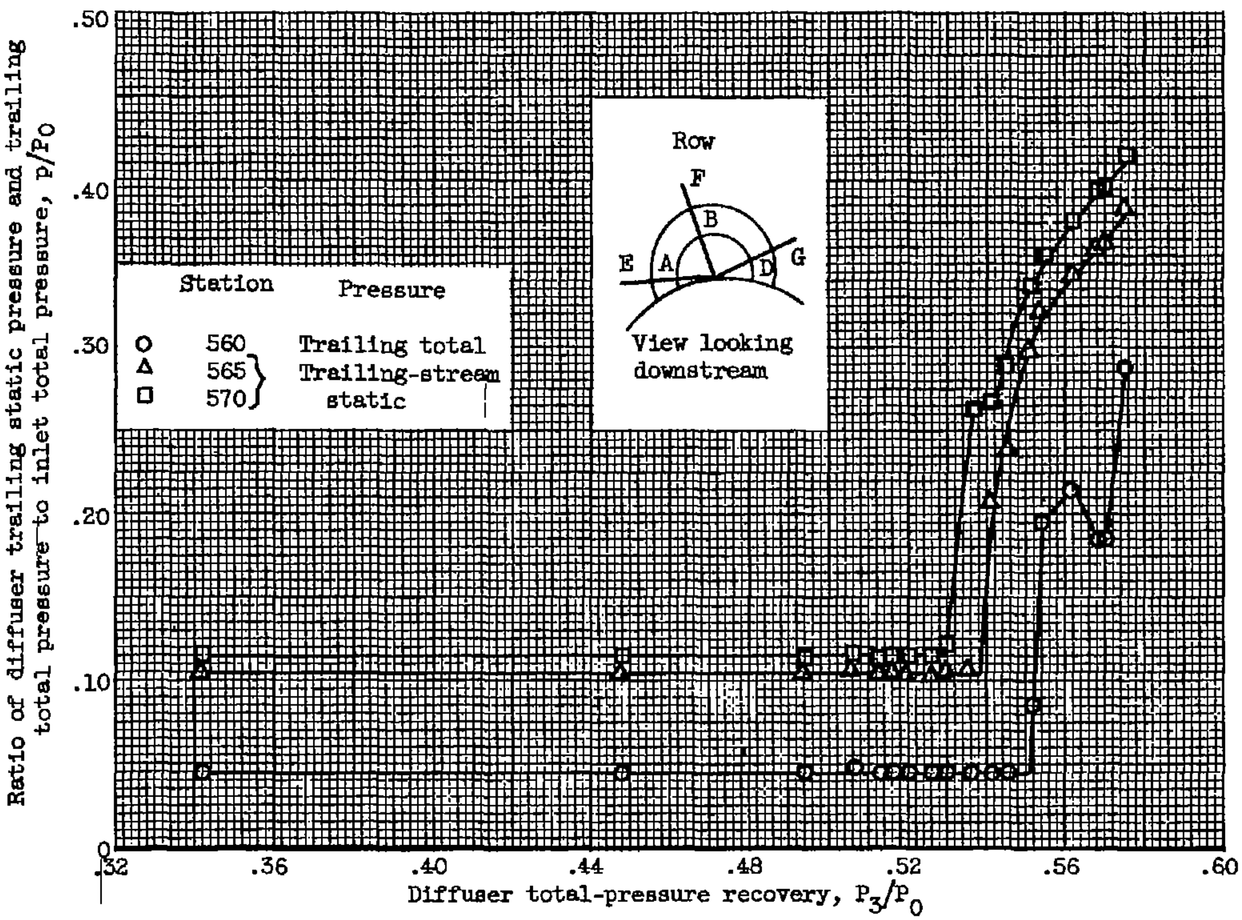
(e) Instrumentation row E (cowl).

Figure 6. - Continued. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



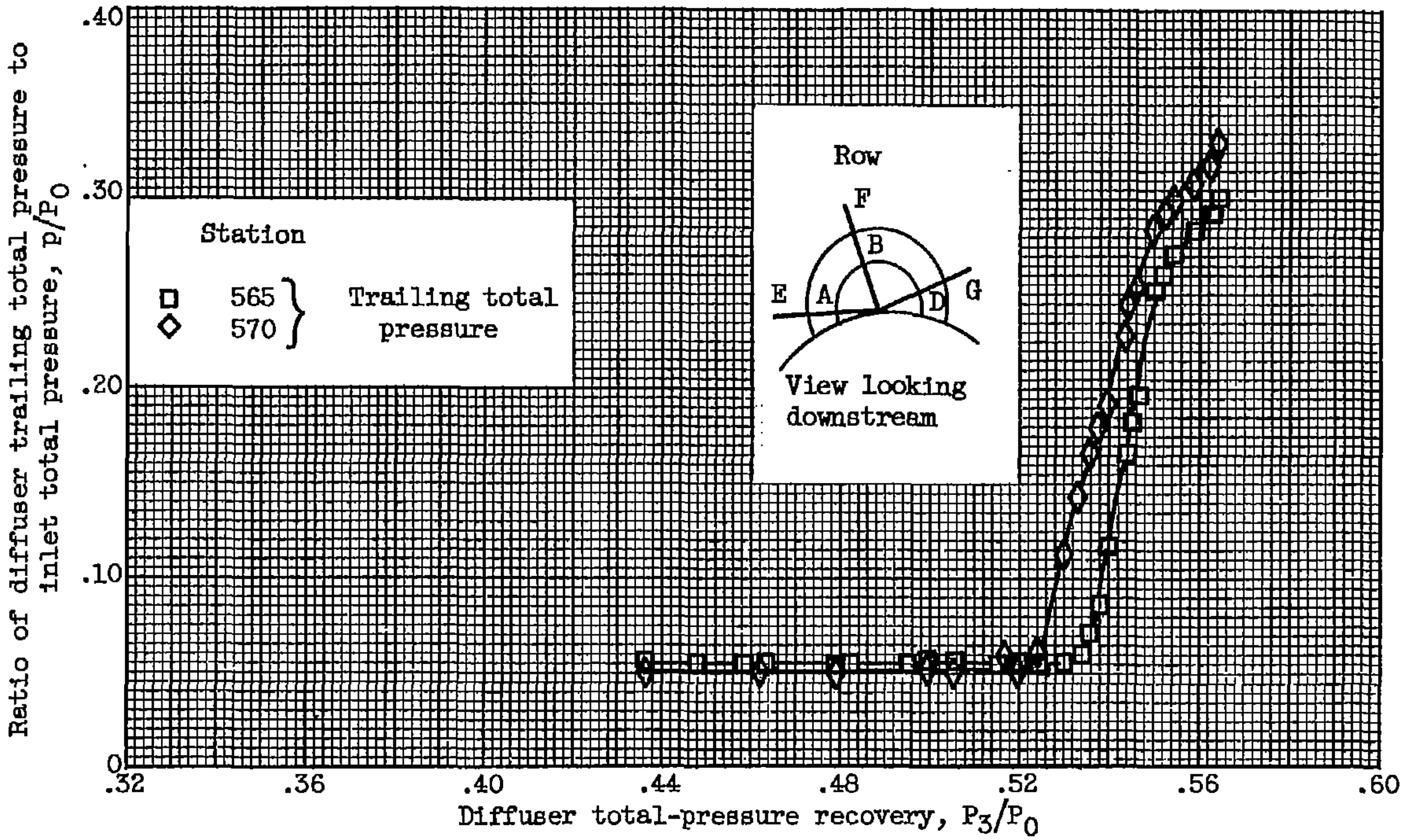
(f) Instrumentation row G (cowl).

Figure 6. - Concluded. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



(a) Cold-flow conditions (combustor not operating).

Figure 7. - Variation of internal-diffuser trailing-stream static pressures and trailing total pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery. Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



(b) Hot-flow conditions (combustor operating).

Figure 7. - Concluded. Variation of internal-diffuser trailing-stream static pressures and trailing total pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery. Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.

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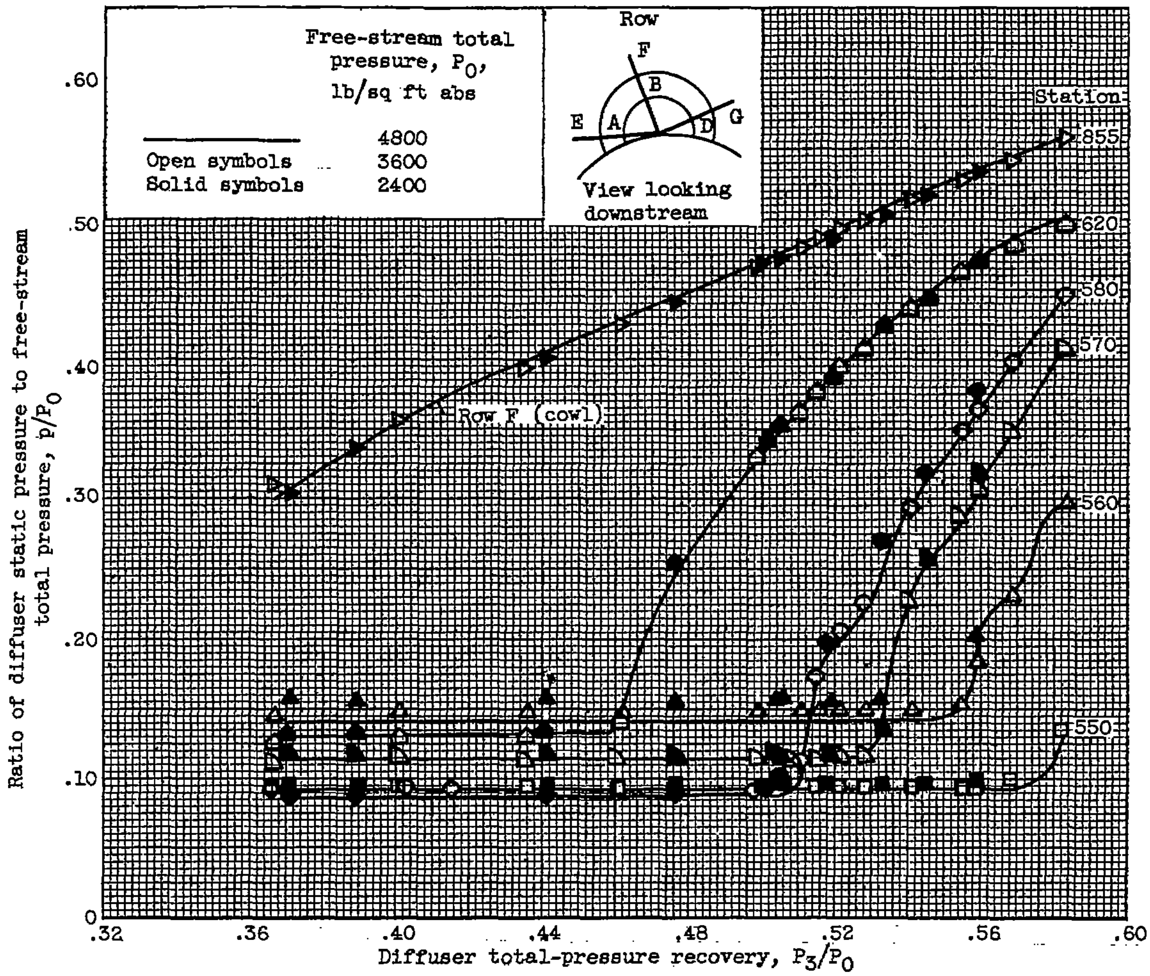

Figure 8. - The effect of free-stream total pressure on the variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Row B (inner body). Free-stream total temperature, 760° F.

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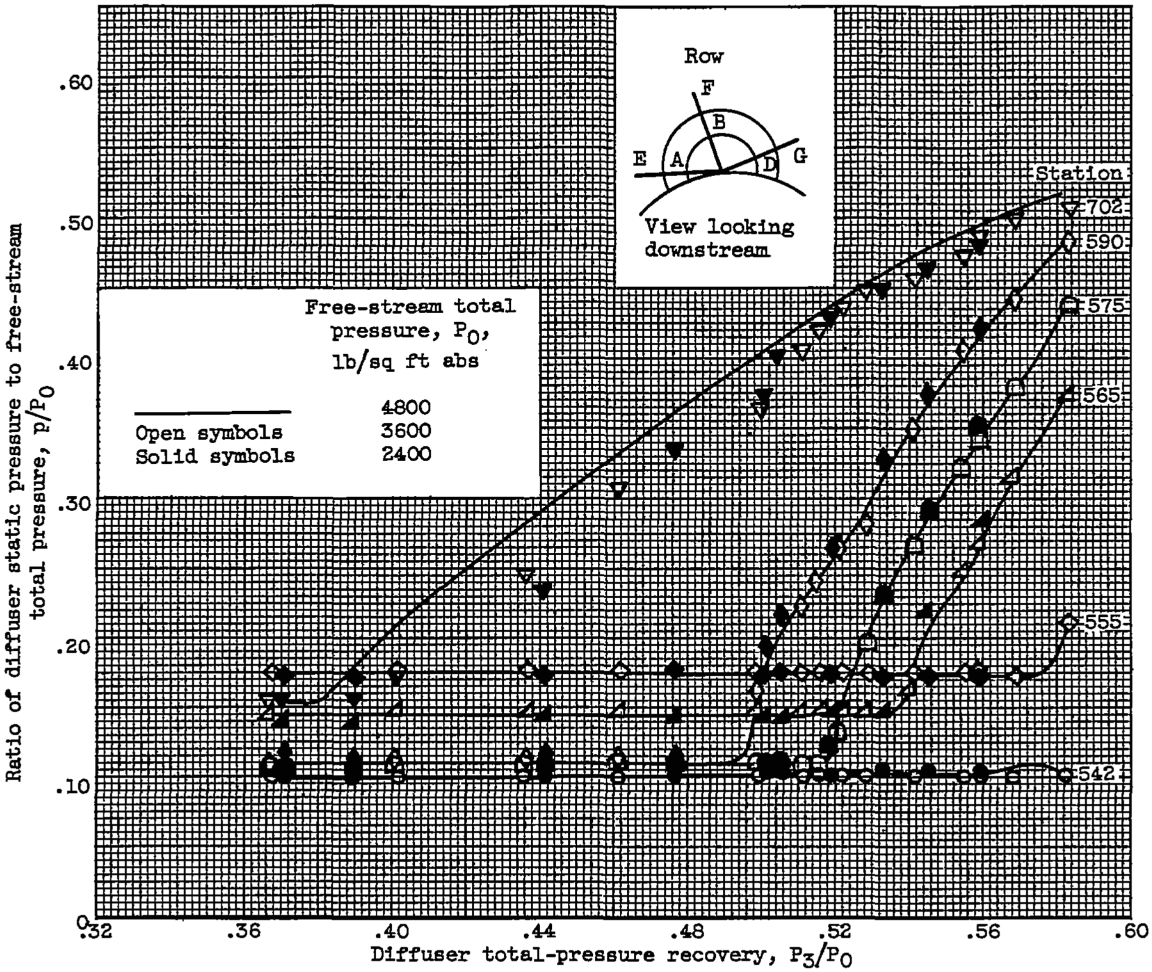

Figure 8. - Concluded. The effect of free-stream total pressure on the variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with diffuser total-pressure recovery under cold-flow conditions (combustor not operating). Row B (inner body). Free-stream total temperature, 760° F.

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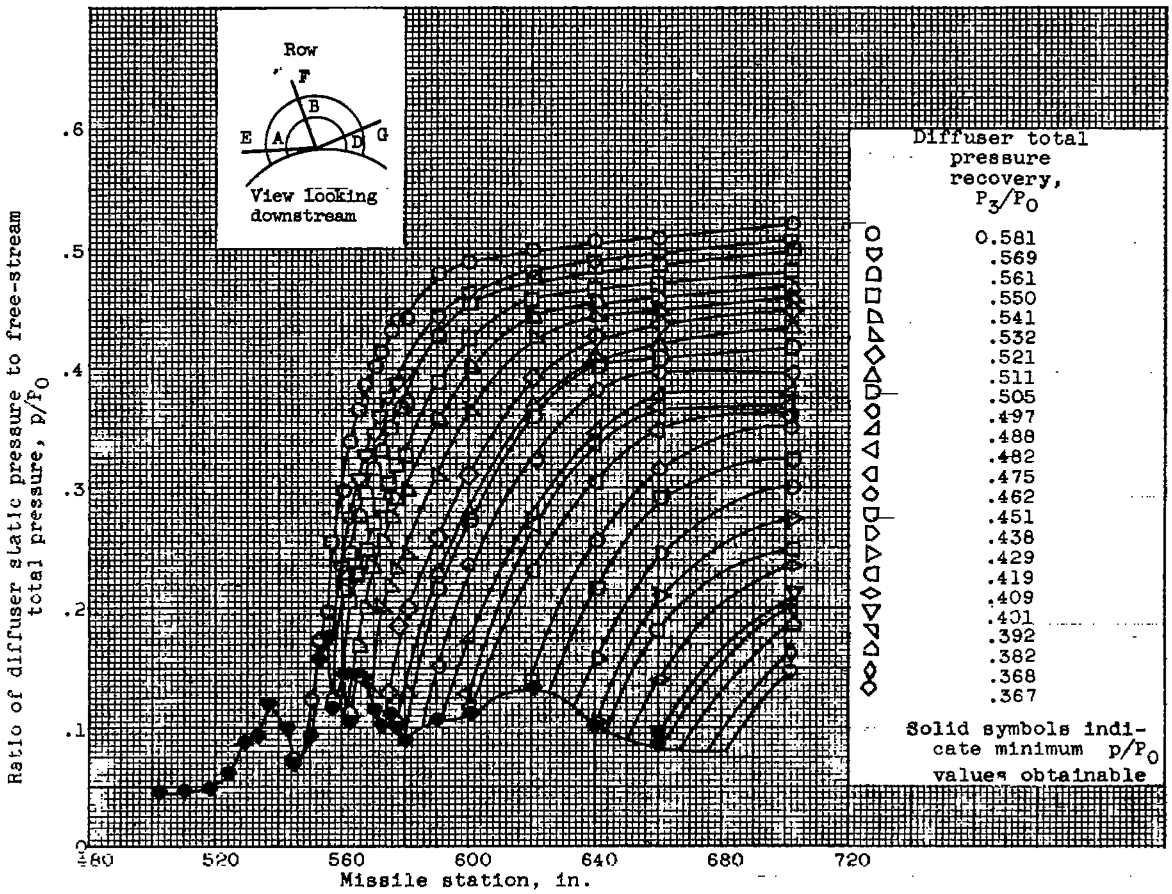

(a) Instrumentation row B (inner body).

Figure 9. - Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressure with missile station under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.

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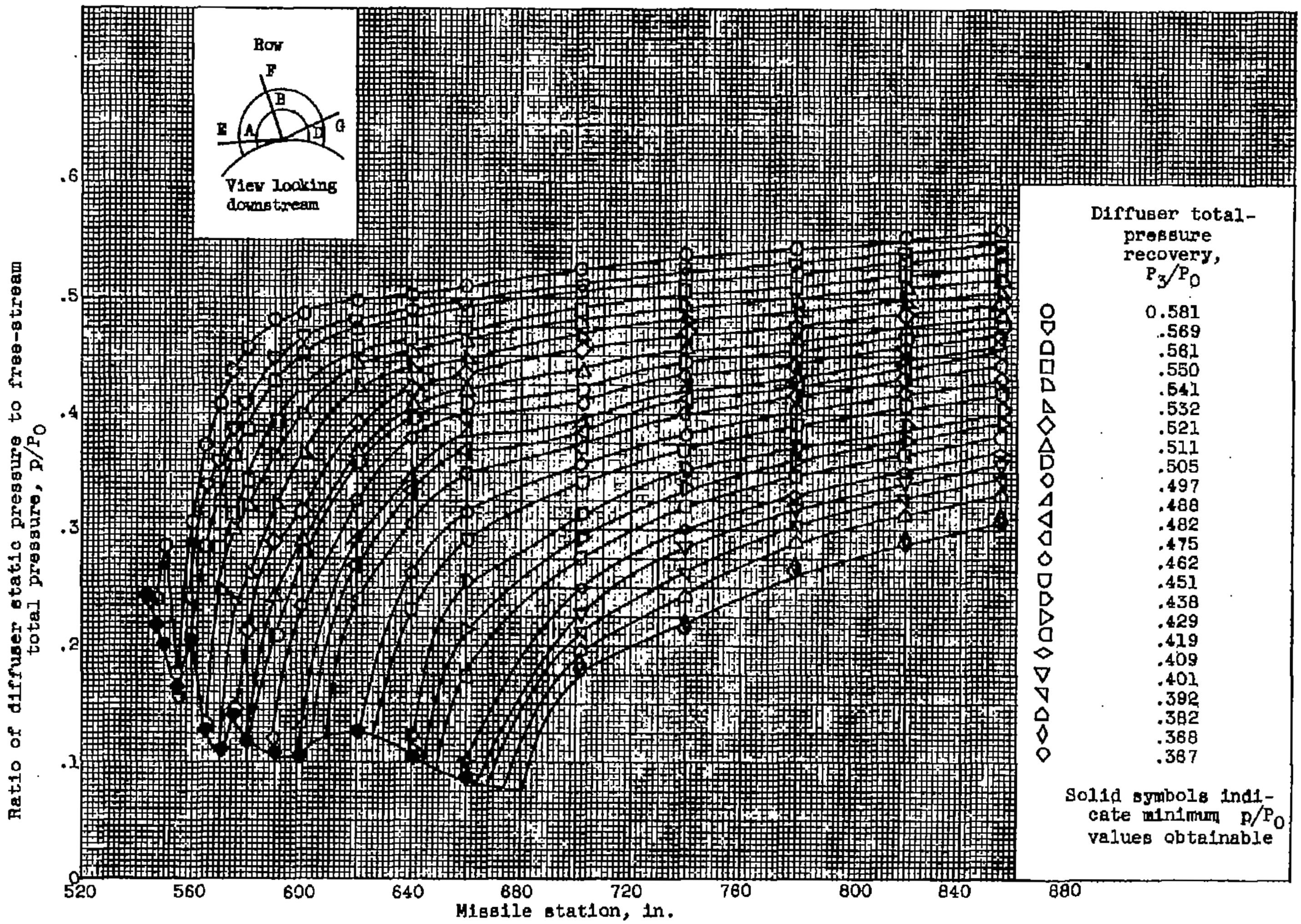


(b) Instrumentation row F (cowl).

Figure 9. - Concluded. Variation of internal-diffuser wall static pressures presented as ratios to free-stream total pressures with missile station under cold-flow conditions (combustor not operating). Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 780° F.

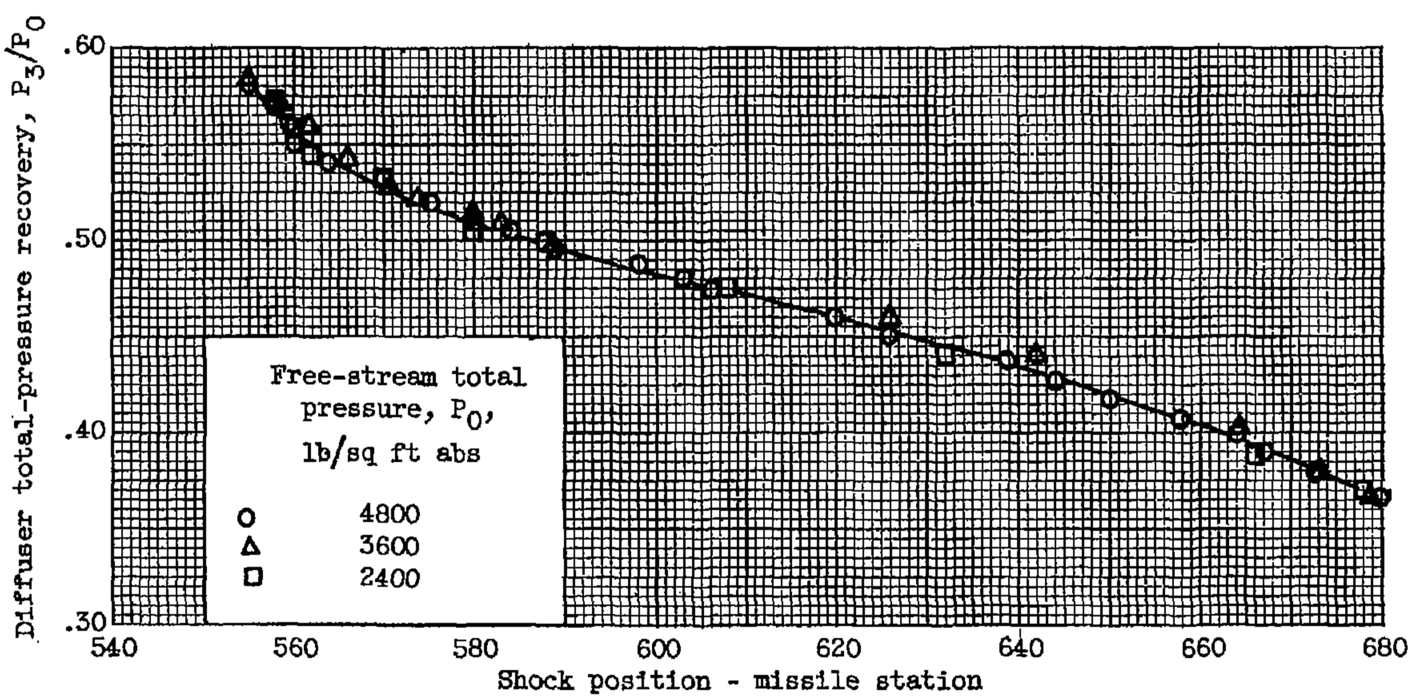
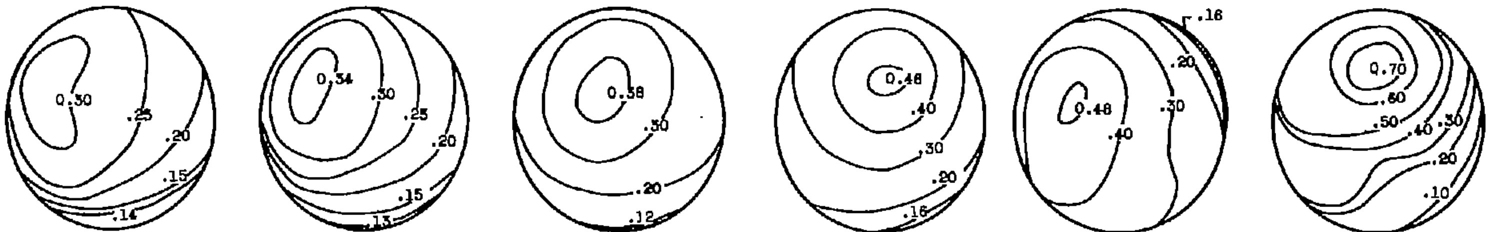


Figure 10. - Relationship between diffuser total-pressure recovery and internal-shock position based on wall static pressures of instrumentation row B (inner body). Free-stream total-pressure effect under cold-flow conditions (combustor not operating).



Diffuser total-pressure recovery, P_3/P_0, 0.5805; average Mach number, M_{av}, 0.242; profile factor, $\Delta M/M_{av}$, 0.157; continuity Mach number, M_{con}, 0.228.

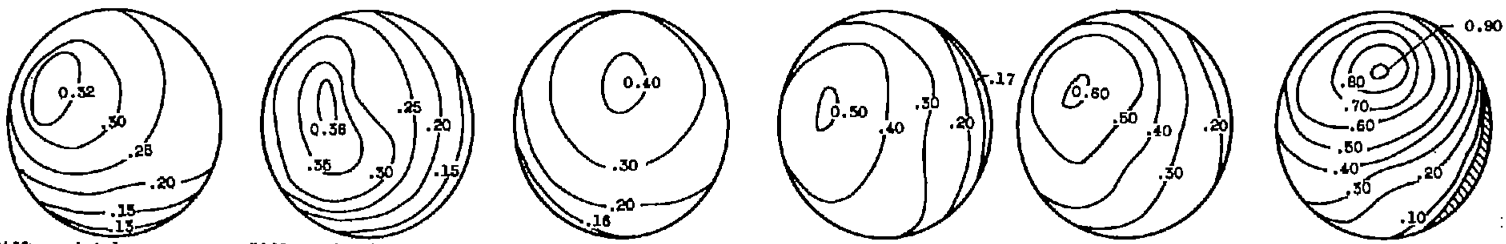
Diffuser total-pressure recovery, P_3/P_0, 0.5414; average Mach number, M_{av}, 0.261; profile factor, $\Delta M/M_{av}$, 0.166; continuity Mach number, M_{con}, 0.245.

Diffuser total-pressure recovery, P_3/P_0, 0.4975; average Mach number, M_{av}, 0.274; profile factor, $\Delta M/M_{av}$, 0.219; continuity Mach number, M_{con}, 0.269.

Diffuser total-pressure recovery, P_3/P_0, 0.4624; average Mach number, M_{av}, 0.322; profile factor, $\Delta M/M_{av}$, 0.235; continuity Mach number, M_{con}, 0.292.

Diffuser total-pressure recovery, P_3/P_0, 0.4288; average Mach number, M_{av}, 0.352; profile factor, $\Delta M/M_{av}$, 0.212; continuity Mach number, M_{con}, 0.317.

Diffuser total-pressure recovery, P_3/P_0, 0.3824; average Mach number, M_{av}, 0.422; profile factor, $\Delta M/M_{av}$, 0.400; continuity Mach number, M_{con}, 0.361.



Diffuser total-pressure recovery, P_3/P_0, 0.5609; average Mach number, M_{av}, 0.251; profile factor, $\Delta M/M_{av}$, 0.174; continuity Mach number, M_{con}, 0.236.

Diffuser total-pressure recovery, P_3/P_0, 0.5207; average Mach number, M_{av}, 0.266; profile factor, $\Delta M/M_{av}$, 0.216; continuity Mach number, M_{con}, 0.256.

Diffuser total-pressure recovery, P_3/P_0, 0.4824; average Mach number, M_{av}, 0.299; profile factor, $\Delta M/M_{av}$, 0.204; continuity Mach number, M_{con}, 0.278.

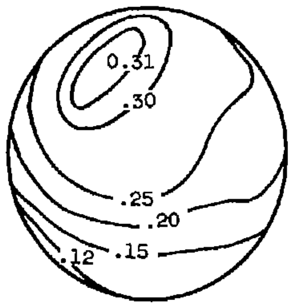
Diffuser total-pressure recovery, P_3/P_0, 0.4377; average Mach number, M_{av}, 0.345; profile factor, $\Delta M/M_{av}$, 0.233; continuity Mach number, M_{con}, 0.309.

Diffuser total-pressure recovery, P_3/P_0, 0.4011; average Mach number, M_{av}, 0.399; profile factor, $\Delta M/M_{av}$, 0.270; continuity Mach number, M_{con}, 0.342.

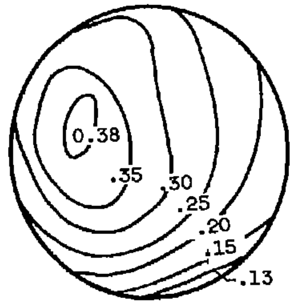
Diffuser total-pressure recovery, P_3/P_0, 0.3668; average Mach number, M_{av}, 0.468; profile factor, $\Delta M/M_{av}$, 0.447; continuity Mach number, M_{con}, 0.378.

(a) Cold flow (combustor not operating).

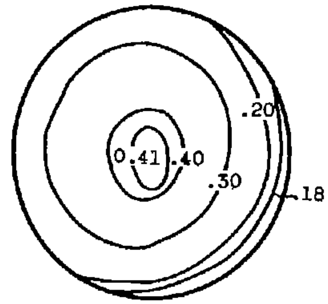
Figure 11. - Diffuser Mach-number contours for various diffuser total-pressure recoveries with average Mach number, continuity Mach number, and flow profile factor at missile station 855 (station 3). View looking downstream. Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 760° F.



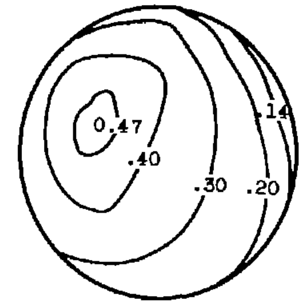
Diffuser total-pressure recovery, P_3/P_0, 0.564; average Mach number, M_{av}, 0.238; profile factor, $\Delta M/M_{av}$, 0.200; continuity Mach number, M_{con}, 0.234.



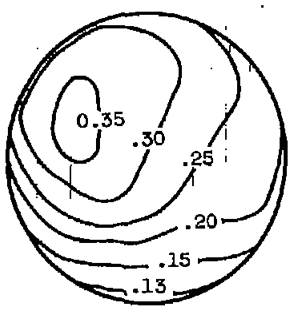
Diffuser total-pressure recovery, P_3/P_0, 0.520; average Mach number, M_{av}, 0.276; profile factor, $\Delta M/M_{av}$, 0.204; continuity Mach number, M_{con}, 0.256.



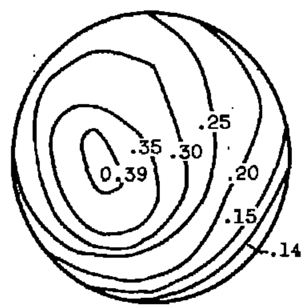
Diffuser total-pressure recovery, P_3/P_0, 0.484; average Mach number, M_{av}, 0.297; profile factor, $\Delta M/M_{av}$, 0.201; continuity Mach number, M_{con}, 0.276.



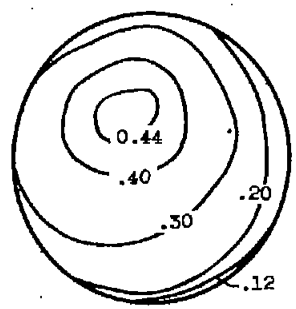
Diffuser total-pressure recovery, P_3/P_0, 0.448; average Mach number, M_{av}, 0.328; profile factor, $\Delta M/M_{av}$, 0.230; continuity Mach number, M_{con}, 0.302.



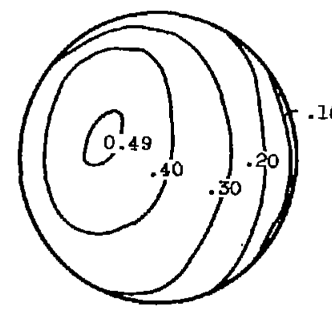
Diffuser total-pressure recovery, P_3/P_0, 0.540; average Mach number, M_{av}, 0.255; profile factor, $\Delta M/M_{av}$, 0.213; continuity Mach number, M_{con}, 0.246.



Diffuser total-pressure recovery, P_3/P_0, 0.506; average Mach number, M_{av}, 0.273; profile factor, $\Delta M/M_{av}$, 0.213; continuity Mach number, M_{con}, 0.264.



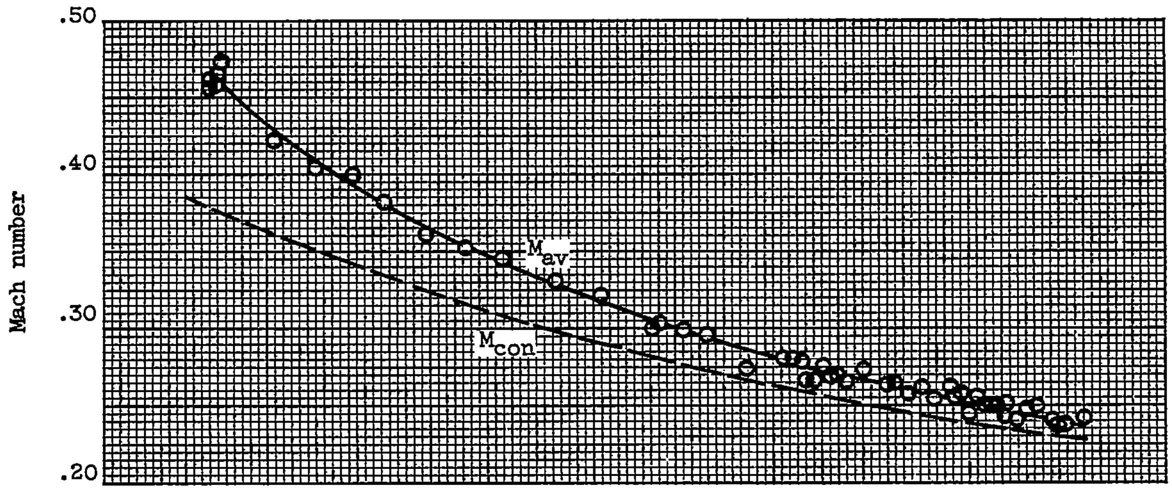
Diffuser total-pressure recovery, P_3/P_0, 0.459; average Mach number, M_{av}, 0.317; profile factor, $\Delta M/M_{av}$, 0.211; continuity Mach number, M_{con}, 0.294.



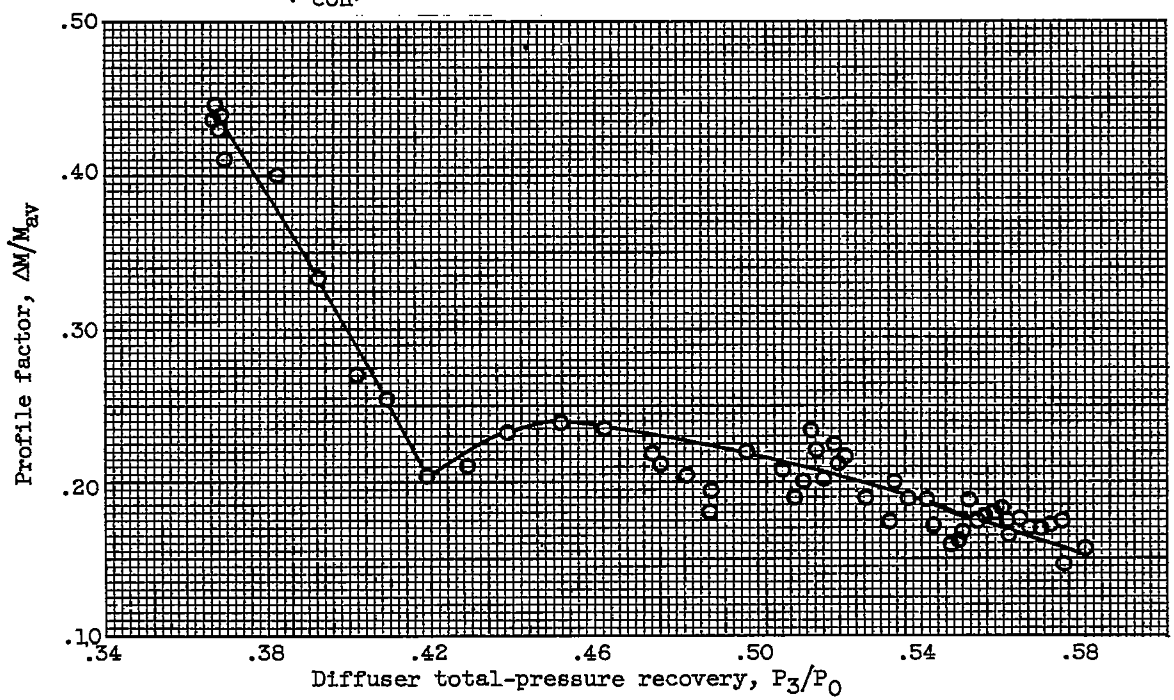
Diffuser total-pressure recovery, P_3/P_0, 0.437; average Mach number, M_{av}, 0.343; profile factor, $\Delta M/M_{av}$, 0.215 continuity Mach number, M_{con}, 0.310.

(b) Hot flow (combustor operating).

Figure 11. - Concluded. Diffuser Mach-number contours for various diffuser total-pressure recoveries with average Mach number, continuity Mach number, and flow profile factor at missile station 855 (station 3). View looking downstream. Free-stream total pressure, 4800 pounds per square foot absolute; free-stream total temperature, 780° F.



(a) Comparison of average Mach number (M_{av}) and continuity Mach number (M_{con}).



(b) Variation of flow profile factor $\frac{\Delta M}{M_{av}}$.

Figure 12. - Diffuser exit-flow parameters as functions of diffuser pressure recovery at missile station 855; cold flow. Free-stream total pressure, 4800 pounds per square foot; free-stream total temperature, 760° F.

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